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AMERICAN METEOROLOGICAL JOURNAL.

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THE AMERICAN

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CURRENT NOTES.

THE DURATION OF A LIGHTNING-FLASH.—Some curious information has been given lately on this subject. Mr. A. S. Barker photographed outside objects, on an excessively dark night, by the light of lightning alone. The wind was strong and the interesting feature was distinctly brought out, when the plates were developed, that the foliage had perceptibly moved during the exposure. The flash must therefore have a measurable interval, probably decidedly longer than the thousandth or ten-thousandth of a second, as got by Wheatstone. His method was of the same nature but the eye was employed as receiving instrument. By using a photographic sensitive plate instead of the eye, a decided improvement is introduced. The problem is a pretty one and deserves further study, and we commend it to skilled photographers. In actual experiment the photograph should be taken of some object, such as a rotating wheel, of which the velocity is great and uniform.

WATER IN THE WESTERN ARID REGION.—The finding of subterranean water by boring, with a view of getting a surface flow for watering stock, thus rendering otherwise valueless lands available for grass, is being prosecuted on the Staked Plains of Texas. In relation to some late efforts of this kind, the Texas *Live-Stock Journal* gives an account of boring in Hockley County. The well was begun lately and water was found at seventy-nine feet that flowed at the surface. The boring was

continued to a depth of 137 feet, but the flow was no stronger. A pump was then put in and thirty to forty gallons per minute were obtained. When the pump is not running the water from the pump flows at the rate of about two gallons per minute constantly.

This shows two things: That pure water may be gotten by boring on plains where the surface water is absent, or, as in this special case, alkali water is the surface water. Two other wells are being bored, and one of these will be carried to 1,500 feet, if necessary, to obtain a strong permanent flow. If water can thus be obtained on the Staked Plains of Texas, one of the most arid regions of the country, there is no reason why it may not generally be reached throughout the plains region.

Ozone and Pneumonia.—The physical properties of ozone as a chemical entity being quite definitely understood, and experiment having proven it, in limited quantities to produce stimulating effects upon mucous surfaces, and, in greater quantities, irritating effects, investigations naturally followed to determine the influences of the varying quantities of *atmospheric* ozone upon such surfaces.

The recent valuable contribution, by Dr. Draper, upon the relation that atmospheric ozone bears to the death-rate from pneumonia, in New York City, supplies us with quite definite information on some points relating to this subject.

In answer to the question, "what meteorological condition is most likely to produce pneumonia?" Dr. Draper says:—"After comparing many thousands of observations from the self-recording barometer, thermometers (dry, wet and sun), hygrometer, anemometers and pulviometer, with the mortuary statistics, there could not be found any continuous connection between the observations and the prevalence of pneumonia- But when ozone was taken into consideration, there was found to be a very close connection between its observations and the death-rate from this disease."

Dr. Draper's observations extending over the eight years ending December, 1885, show that the annual average death-rate

from pneumonia increased with an increase in the annual average of ozone, and decreased with an annual average decrease in the quantity of ozone during these years. The diagram and the valuable tables given in the article also show that the average amount of ozone for the month of March for the eight years considered was greater than the average for any other month in the series and that during the month of March for the same years the average death-rate from pneumonia was greatest. The death-rate in some months was apparently augmented by an excess of ozone in the preceding month as a cause of attack.

The results of the observations made by Dr. Draper in New York correspond very closely with those attained by Dr. Baker in relation to ozone and pneumonia in Michigan, who found that there seldom was an exception to the proposition that during those months when the day and night ozone was above the average for the year there was a greater prevalence of pneumonia.

Relative to the cause of the variation in the amount of atmospheric ozone present Dr. Draper observed that during the year 1883, especially noted for its "rose-red sunrises and sunsets," there was a marked diminution in the quantity of ozone, that in August, September, October, November and December, being especially small. The average death-rate that year, however, was among the greatest for the eight years. This exception to the general rule may possibly be accounted for by unusual changes in the chemical rays affecting the test. A. W. N.

WEATHER PREDICTION IN NEW ZEALAND.—A series of manuscript documents prepared in November, 1885, by Dr. James Hector, director of the Colonial Museum, Wellington, N. Z.: for Captain Barker, U. S. N., has been deposited by the latter with the Hydrographic Office in Washington; by the kindness of Captain J. R. Bartlett. I have lately had opportunity of examining these papers and present herewith a brief account of them.

Two sets of small diagram-maps illustrate all the types of barometric conditions discovered in southern Australia and in New Zealand since the inter-colonial weather exchange was

established four years ago. There are twenty such types for the former and twenty-four for the latter region. No difficulty has been found in referring all daily weather maps published at Melbourne to one or another of the Australian types, so that much time and trouble are saved in thinking out the solution of every day's indications, and the expense of cabling the Australian observations to New Zealand is greatly reduced. Special statement is made when needed in cases of unusual baric gradients or of abnormally large or small areas of high or low pressure. About twenty-four hours is required for the passage of a type of weather from Australia to New Zealand. It is especially interesting to readers north of the equator to discover the inversion of north and south in the description of wind directions, while east and west remain the same. For example, the most common type of disturbance in New Zealand results from the eastward passage of a low pressure area south of the southern island. When its centre is about 800 miles to the W. S. W. a cloud bank looms up off shore on the west coast and a heavy swell rolls in from the west. A little later, there are north-west or westerly winds with rain on the west coast while cirrus clouds and fine weather are experienced on the east. When the center of low pressure stands south of the islands, south-west winds and clearing weather appear on the west coast of the South Island, north-west winds with rain on the west of North Island, and dry north-west winds on the east coast of South Island, succeeded by a "Southerly Baster" with rain or snow according to the season. Finally, as the storm center moves far away to the south-east, southerly winds and clearing sky are found in all districts. These successive attitudes are illustrated in four type diagrams. A second example shows in these diagrams the passage of a low pressure center from north-west to south-east, via Cook's strait: such disturbances have steep gradients and move rapidly; they bring south-east, east and north-east winds with heavy rain on the east coast of the South Island—this recalls the northeast rains of our eastern coast, preceding the center of storms that come up in the autumn from the West Indies.—A few samples of the daily weather charts for New Zealand are included in the

collection. They are conducted by Mr. R. A. Edwin from telegraphic reports from thirty-four stations, equally divided between North and South Islands. Isobars of readings lower than thirty inches, are drawn in black; higher than thirty inches, in red. The isobars and their resulting winds over the adjacent ocean surface are necessarily largely hypothetical, but they seem to be drawn so as to conform best with the weather changes from day to day on the islands. W. M. D.

OBSERVATIONS OF THUNDERSTORMS.—A circular has been issued by the New England Meteorological Society, from which the following is extracted:

Observations of Thunderstorms in co-operation with the United States Signal Service: second season—1886.

Thunderstorms will constitute a subject of special investigation during the summer months, on much the same plan as in 1885. The phenomena of thunderstorms have been chosen for this study, as offering at once the greatest variety of features easily observed, and promising in return the most interesting results. Volunteer observers to take part in the study are wanted in all parts of New England. The desired observations are classified as follows:

Class A. No instruments required. Simple records of the time of beginning and ending of rain, when thunder is first heard and loudest, and of the direction of wind and its changes.

Class B. Ordinary instruments needed. A thermometer and a tin can for collecting rain. A somewhat more detailed record of rain, wind, temperature, thunder, etc., during the passage of a storm.

Class C. Good instruments needed. Better measures of rain and temperature, with barometer readings if possible; and especially more careful observations on clouds.

This division into classes need not be closely followed. Observers of Class A may add, for example, temperature of Class B, or clouds of Class C to their other subjects of record.

Days when observations are wanted: (1) Observations are to be taken through June, July and August whenever a thunder-

storm can be seen or heard. (2) Observations are also desired at regular intervals from noon to six P. M. on certain days, whether a thunderstorm is in progress or not. These days will be called Term-days; they will be appointed one and a half or two days in advance by special message from the Chief Signal Officer in Washington, and will be announced to the public by telegraphic reports to all newspapers of the New England Associated Press. They will be days on which thunderstorms are expected.

Instructions and blanks for observations will be distributed to volunteers in the latter part of May. No one need hesitate to undertake the work from lack of practice, as the instructions give all necessary information, and the simpler class of records (A) can easily be kept by any intelligent boy or girl.

Special circulars addressed to yachtsmen and pilots and to amateur photographers may be had on application.

The Council of the Society requests the assistance of all persons in New England interested in this investigation, not only in keeping records themselves, but particularly in extending the number of observers in their neighborhood.

W. M. Davis, Sec'y N. E. Met. Soc.,
Cambridge, Mass.

The back of the circular contains a brief account of two storms in 1885, illustrated by two small maps. There is also a *card* of enlistment, to be filled out by each observer. It reads as follows:

Volunteer observations of thunderstorms—1886. I will make observations of thunderstorms to the best of my ability according to the instructions for Class....in the Village of....State of...., during June, July and August, 1886. In case my record should be interrupted by absence or otherwise, I will, if possible, secure an observer to take my place. (Signature.)....Permanent address....P. O.,....State.

Increase of Thunder and Hail Storms in Europe.—*Le Moniteur des Assurances*, Paris, April 15, publishes an elaborate article on the increase of storms in Europe during the past

fifty years. It quotes from a work by Herr Bruhn, manager of the Association for Insurance against Fire, Lubeck, that the data collected by said company for fifty-eight years (instituted in 1827), show the increase to be in the proportion of one to ten. The Lubeck association named, insures in the district north from the Elbe, and chiefly farm buildings and contents; the buildings having mainly inflammable (thatch and shingle) roofs. This district has numerous lakes, and now suffers greatly from lightning strokes and fires thereby occasioned. The company's statistics show that of 1,200 observed thunder storms, 1,100 struck places in the open country, and that inflammable roofs set on fire by the lightning were $2\frac{1}{2}$ times in number the fires causing losses in contents of buildings which had "hard" (slate, tile or metal) roofs; also, that the amount of losses through lightning in buildings having inflammable roofs was twenty times as great as that of buildings struck which had hard roofs. Herr Bruhn gives some tables, of part of which the following is a condensation:

Periods of observation.	Number of years.	Average annual amount of risks written.	Average annual number of fires from all causes.	Average of all annual losses.	Average annual number of lightning fires.	Average annual losses from lightning fires.	During whole period of observation. Ratio of general fire loss to each $1000 insured.	During whole period of observation. Ratio of losses from lightning fires to each $1,000 insured.
1827-1834.......	8	$4,299,611	4.25	$5,455	0.5	$178	$1.27	$0.04
1835-1844.......	10	10,798,403	18.90	16,201	0.5	738	1.50	.07
1845-1854.......	10	18,240,364	35.10	31,834	3.10	2,773	1.75	.15
1855-1864.......	10	27,084,643	45.80	50,884	7.20	5,847	1.90	.27
1865-1874.......	10	34,527,861	74.30	71,226	15.70	15,591	2.07	.45
1875-1884.......	10	37,616,439	88.00	83,531	16.20	14,819	2.22	.40

The foregoing table evidences that for the first eight years the losses of the company by lightning were only $\frac{1}{32}$ of all the losses, whilst in the last two decades, taken together, the lightning losses formed about $\frac{1}{5}$ of all the losses.

M. Bezold, who has been for fifteen years examining the subject of fires arising from lightning strokes in Bavaria, the data forming part of the observations made for the Bavarian Insurance Company, states that in the province named, the losses

arising from lightning have tripled during the last fifty years. He divides that period in the record as follows:

	Number of years.	Whole number of fires caused by lightning.	Annual average of lightning fires.
1833-1843....................	11	355	32.3
1844-1865....................	22	1,142	51.9
1866-1879....................	14	1,550	103.3
1880-1882....................	3	401	133.6
	50	3,448	69.0

American Exchange and Review.

Royal Meteorological Society.—The usual monthly meeting of this society was held on Wednesday evening, the 19th of May, at the institution of civil engineers; Mr. W. Ellis, F. R. A. S., President in the chair.

Mr. L. T. Cave and Rev. C. Malden, M. A., were elected Fellows of the Society.

The following papers were read:

(1) "The Severe Weather of the past Winter, 1885–6," by Mr. C. Harding, F. R. Met. Soc. The author shows that the whole winter was one of exceptional cold, not so much on account of any extremely low temperatures experienced but more from the long period of frost and the persistency with which low temperature continued. In the south-west of England there was not a single week from the commencement of October to March 21st in which the temperature did not fall to the freezing point. In many parts of the British Islands frost occurred in the shade on upwards of sixty nights between the beginning of January and the middle of March, and during the long frost which commenced in the middle of February and continued until March 17th the temperature fell below the freezing point in many places on more than thirty consecutive nights. At Great Berkhamsted in Hertfordshire frost occurred on the grass on seventy-three consecutive nights from January 5th to March 18th. The winter of 1885–6 was the only one in which there was skating on he water of the London Skating Club, in Regent's Park, in each

of the four months, December to March, since the formation of the club in 1830, and there are but four records of skating in March, during the fifty-six years, and none so long as in the present year. With regard to the temperature of the water of the Thames at Deptford it is shown that the total range from January 8th to March 20th was only 6°, while from March 1st to 19th the highest temperature was 36.5° and the lowest 35°. The temperature of the soil at the depth of one foot was generally only about 2° in excess of the air over the whole of England, and from March 1st to 17th the earth was cooler than usual by amounts varying from 6.3° at Lowestoff to 8.5° at Norwood. The facts brought together showed that the recent winter was one of the longest experienced for many years, and that in numerous ways it may be characterised as "most severe."

(2) "Description of an Altazimuth Anemometer for recording the vertical angle as well as the horizontal direction and force of the Wind, by Mr. L. M. Casella. The author describes an anemometer he has made which records continuously on one sheet the pressure, direction and inclination of the wind.

(3) "Earth Temperatures, 1881–1885," by Mr. W. Marriott, F. R. Met. Soc. This is a discussion of the observations of the temperature of the soil at various depths below the surface which have been regularly made at 9 A. M. at several of the stations of the Royal Meteorological Society during the past five years. The results show that the temperature of the soil at one foot at nearly all the stations in the winter months is about the same as that of the air, while in the other months of the year the temperature of the soil is higher than that of the air at all except that of the London stations.

(4) "Note on the After-Glows of 1883–1884," by Mr. A. W. Clayden, M. A., F. R. Met. Soc. The author suggests that the after-glows were the result of the water vapour erupted from Krakatao, and that the dust and other ejecta played but a secondary part in the production of the phenomena.

REVIEW FOR MAY.—*Barometric pressure*—On the 1st, two maxima are to be observed; one over Britain and another over

the Baltic, but on the 2nd only one high pressure remains over Scandinavia where the barometer is as high as 30.40. A low pressure has formed in the S. E. over Italy and Austria but disappear in the east after causing very low temperature and snow over eastern Germany and western Russia. Over western Europe the weather remains calm and clear with almost normal temperature; on the 8th the high pressure travels partly to Britain and partly to Central Europe on the approach of a minimum on the Scandinavian Coast, which is situated on the 1st over the Baltic, and on the 10th forms an area of low pressure over N. E. Central Europe and Britain causing only in Germany some precipitation. On the 12th appears a low pressure in the S. W., growing more intense as it travels in a N. E. direction over Holland and Southern England, where the barometer has fallen as low as 21.10, and causing considerable precipitation over Holland or Germany. Taking a northerly course it has reached Norway on the 16th and disappears in the N. E. on the 17th; another coming from the west follows; at the same time a maximum appears over Italy and travels to western Russia on the 19th; the low pressure in the N. W. now disappears and clear weather with high temperature prevails over Central Europe. A small depression in the S. W. disappears on the 21st, and high temperature is now general (up to almost 90°) over the greatest part of Europe. A high pressure has taken the place of the minimum over Britain just spoken of while low pressure is to be seen in the northern parts of Scandinavia, this also disappears on the 24th, and the maximum over Britain travels to the N. E. over the Baltic; three very small minima loose some precipitation over Holland, but on the following day an area of low pressure has advanced from the N. W., spreading as far south as France and Austria, and causing general rainfall with strong S. W. winds, and almost normal temperature; on the 27th it has divided in two parts; one in the N. W. and another in the S. W.; on the 28th, however, a well developed minimum with a stand of the barometer in the center of about 29.10 is observed on the eastern Coast of Scotland. A maximum has now formed over France, and recedes on the 21st to western Russia; at the same

time the minimum in the N. W. travels to the North, and a maximum takes its place, while a low pressure appears in the S. W., then the character of the weather is changed, and N. E. winds now prevail over Britain and Central Europe with partly clear weather.

Temperature: Germany—below the mean: 1–12, 15–17, above the mean: 13, 14, 18–31; lowest, 32° on the 3d at Chemnitz, highest, 88° on the 31st at Cassel.

Ireland, Valentia—below the mean, 1, 2, 12–16, 18, 19, 23–30; above the mean, 3–11, 17, 20–22; lowest, 41° on the 13th; highest, 64° on the 31st.

Russia, St. Petersburg—below the mean, 1–6, 11–13; above the mean, 7–10, 14–31; lowest, 28° on the 1st; highest, 74° on the 22nd.

Sweden: Stockholm—below the mean, 1, 2, 4, 10–14, 17; above the mean, 3, 5–9, 15, 16, 18–31; lowest, 35° on the 2nd; highest, 74° on the 21st.

Lapland, Haporanda—below the mean, 1–3, 10–14, 26–28, 30, 31; above the mean, 4–9, 15–25, 29; lowest, 26° on the 1st; highest, 60° on the 15th, on the 23d navigation was opened.

M. Buysman.

Middelburg, Holland.

Derivation of the term "Trade-wind."—The original meaning of the word *trade* has been so far replaced by an acquired meaning, that a popular error has arisen as to the derivation of the term, *trade-wind.* Webster's dictionary says the trade-wind is "so-called because of great advantage to navigators, and hence to trade." Worcester's dictionary explains it as "so-called because favorable to commerce." But looking further back, the following extract from Skeat's Etymological Dictionary is instructive: "Trade-wind, a wind blowing in a constant direction, formed from the phrase, 'to blow trade' to blow always in the same course." A step further discovers that trade is "properly that path which we *tread* . . It once meant, literally, a *path* . . . The M. E. [Middle English] words are *tred* and *trod,* both in the sense of foot-mark. All from the A. S. [Anglo-Saxon] *tredan* to tread."

The following extracts show the early use of the term, two or three centuries ago, by the navigators of that time.

Hakluyt wrote, "The wind-blowing trade, without an inch of sail, we spooned before the sea." (Voyages, iii, 849, published in 1600).

Dampier said, "Trade-winds are such as do blow constantly from one point or quarter of the compass. There are divers sorts of these winds; some blowing from East to West, some from South to North, others from West to East, etc. Some are constant in one quarter all the year; some blow one-half the year one way, and the other six months quite contrary; and others blow six months one way, and then shifting only eight or ten points, continue six months more, and then return again to their former stations, as all these shifting trade-winds do." (Discourse of the Trade-winds, in his Voyages and Descriptions, London, 1705, Vol. ii, pt. iii, p. 1, 2). W. M. D.

THE BLIZZARD.—Among the American weather phenomena, the blizzard is one which is so distinctive as to well deserve a separate name. It is a cold-wave gale with very low temperature and fine day driving snow. Its home is in the North-west but it may occur elsewhere,—less frequently as one passes farther from its home. It is very destructive to unprotected stock and is dangerous to persons exposed to it on the open prairie. The following description is a good one. It is by Mr. C. A. Lounsberry and is taken from the *Northwest Magazine*. It is evident that the writer speaks feelingly on the subject. He says:

"It's a regular blizzard," said the first man I met as I passed from the hotel to the street at Fargo, on the morning of January 7th. "Something like it," I responded, "but you people know but little of the blizzard. I want to tell you about the thoroughbred blizzard, and then tell me if you have ever met such a customer in North Dakota. It was about the middle of December, 1865. Starting from Michigan with a lot of sheep en route for Minnesota, winter came upon me at Belmond, Wright county, Ia. I secured a cabin, situated in a lovely grove,

built sheds and arranged to spend the winter there, passing on to Minnesota in the spring. On the morning in question on every twig frost had gathered. The sun at rising was hid behind a red mantel of clouds. The air was unusually moist. A gentle mist deposited moisture on every twig; the mist turned to rain, the rain to snow. About four inches of snow fell. The thermometer was in the vicinity of the freezing point. About 9 P. M. the wind shifted to the northwest and its velocity increased to about forty miles an hour. It turned cold and each separate flake of snow became a particle of ice, and each had business at some other point than where it fell. As the wind would lift fine dust and whirl it through the air, so this body of snow was lifted. To distinguish the form of a human being ten feet away was impossible. A barn, even, could not have been seen twenty feet in front of one. It was a mad, rushing combination of wind and snow which neither man nor beast could face. The snow found its way through every crack and crevice. Barns and stacks were literally covered by the drifting snow, and, when the storm was over, cattle fed from the tops of stacks. My sheep huddled together in the sheds and many of them were smothered. Persons lost upon the prairies were almost certain to meet with death, unless familiar with the nature of these storms. Those who had ceased to be tenderfeet simply drifted along with the wind, taking advantage perhaps of some friendly drift for rest or a night's lodging, for the cold did not become intense until the wind went down, and there was little danger of freezing unless one became heated and exhausted by fruitless attempts to buck the storm. I learned of many instances where persons were lost in trying to go from the house to the barn, and of other instances where cords were taken from the beds and fastened to the house, so that if the barn should be missed by holding on to the bed cord the house could be found again. During the blizzard the thermometer ranged from twenty above to ten below. After the storm it reached twenty-five below. Much stock was lost, and some families in sparsely settled regions suffered from the blizzard. On the fourteenth of February, 1866, another blizzard occurred. A party of children returning from a spell-

ing school, in the Chain Lake region of Minnesota, were lost in the storm and badly frozen. In December, 1870, another blizzard occurred. A family, I remember, was badly frozen in Faribault county, Minn., their house having been burned during the storm. One of the children was saved by crawling into a straw pile with a lot of hogs and being kept from freezing by the warmth of their bodies. In January, 1875, another blizzard occurred, doing most damage on the prairies of Kandiyohi county, Minn. This came up in the day time and caught many people on their way to or from market. I was in St. Paul for the purpose of reporting a legislative caucus for a Minneapolis newspaper. The trains were all blockaded and the telegraph wires refused to work. I offered twenty-five dollars for a team to take me from St. Paul to Minneapolis. It could not be done. I then offered a messenger twenty dollars to go through on horseback. He tried it three times and gave it up.

These were blizzards, and since 1875 I have seen nothing that approached the dignity of or possessed the business qualifications of a blizzard. Without snow a blizzard has no capital to do business on and the snows do not accumulate in North Dakota until after the blizzard season passes. Some of the new comers in Dakota call every storm a blizzard, and not a few of the newspaper correspondents seem to be as familiar with blizzards as the old-time preachers pretended to be with the will of God. At this writing, January 7th, we are having our first severe day during the entire winter. I have been at Fargo most of the time since December 1st, and have been moving about more or less every day and during that time have scarcely worn an overcoat. During November the coldest was five above zero on the thirteenth, while the range generally was from seventeen to forty-five. Slight snow fell on eleven days, in all sixty-four one hundreths of an inch. On the sixth and seventh, just a little rain. In December, on thirteen days the thermometer passed below zero, the coldest being twenty below on the seventh. The range generally was from fourteen to forty-two above. Snow fell on ten days, in all thirty-two one hundreths of an inch and just a little rain on the twenty-eighth and twenty-ninth.

During January up to the fifteenth, the record is as follows:

	Lowest.	Highest.		Lowest.	Highest.
Jan. 1	1.5	20.6	Jan. 9	—39.8	—24.4
Jan. 2	7.1	18.	Jan. 10	—36.8	—13.6
Jan. 3	7.9	15.	Jan. 11	—25.4	— 1.
Jan. 4	5.5	11.6	Jan. 12	—12.2	21.6
Jan. 5	6.3	14.	Jan. 13	0.4	32.1
Jan. 6	—14.4	—11.4	Jan. 14	3.9	21.
Jan. 7	—21.1	—14.	Jan. 15	3.4	2.
Jan. 8	—33.7	—20.			

Snow fell on the fourth, sixth, seventh, fifteenth and sixteenth, in all thirty-seven one hundreths of an inch, making a total snow fall during November, December and half of January of 1.33 of an inch. During the severe weather of the sixth, seventh, eight and ninth, the velocity of the wind was 24 N., 30 N., 26 N., and 16 N. W., with barometer 36–36, and 36–38. I mention these four days because they are fair samples of our severest weather and these samples are not brought out more than three times during the winter, and never last more than four days, and are not as severe upon men or animals as the sleet and rain of Ohio or Indiana. I have seen the months of December, January and February pass with but five cloudy days. Bright skies all winter. The heaviest snow fall comes in March. North Dakota is not in the snow belt; the heavy snows are to be found in Southern Minnesota and Iowa, Southern Dakota and Nebraska.

C. A. LOUNSBERRY.

THE COLORADO METEOROLOGICAL SERVICE.—The organization of the Colorado Meteorological Association, which took place in Denver, January 6, 1885, was reported in the JOURNAL for the following March. We now learn that the Association has established a weather-service, which went into operation at the beginning of April in the present year. The office for the collection and publication of weather-reports is at present located at the Meteorological Observatory of Colorado College, at Colorado Springs, under the direction of Prof. F. H. Loud. A number of newspapers in different parts of the State are supplied weekly with statistics of temperature, cloudiness, and rainfall; and the publication of a series of monthly bulletins was begun with the

number for April. The first newspaper summary was printed on April 13th, and contained reports from eight stations; while that of June 24th comprised nineteen stations, distributed pretty evenly over the area of the State, with the exception of the portion north of Denver. It thus appears that the number of observers has shown thus far an encouraging rate of progress, which will probably be continued in coming months. In view, however, of the great inequalities of surface and the consequent diversity of local weather in Colorado, the adequate representation of the meteorology of the State would require a much larger number.

The nature of the field which the Colorado Association is working is such as to promise results both of scientific value and of economical importance to the citizens of the State, and it is much to be hoped that a sufficient financial support will be forthcoming to secure the permanence and extension of the service, and the perfection of its methods. Thus far it has been sustained by the members of the Association alone; the effort made at the last session of the State legislature to obtain a grant having been unsuccessful. The attempt will probably be renewed next year,—we hope, with a better result.

Opening of the Straits of Mackinac.—The following table shows the date that the first vessel passed through the straits during the last thirty-three years:

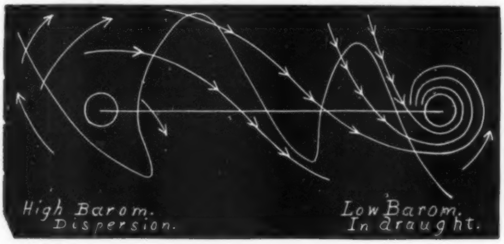
1854	April 25	1865	April 21	1876	April 28
1855	May 1	1866	April 29	1877	April 20
1856	May 2	1867	April 23	1878	Mar. 14
1857	May 1	1868	April 19	1879	April 23
1858	April 6	1869	April 23	1880	April 5
1859	April 4	1870	April 18	1881	May 4
1860	April 13	1871	April 3	1882	April 5
1861	April 25	1872	April 28	1883	April 28
1862	April 18	1873	May 1	1884	April 28
1863	April 17	1874	April 29	1885	May 5
1864	April 23	1875	April 28	1886	April 21

Chicago Times.

CYCLONES, ANTICYCLONES, AND PERICYCLONES.

About twenty years ago, Galton proposed the term Anticyclone as a name for an area of high atmospheric pressure. He wrote: "We ought to admit that an area of barometric elevation is usually a locus of dense descending currents, and therefore of a dispersion of a cold, dry atmosphere, plunging from the higher regions upon the surface of the earth, which, flowing away radially on all sides, becomes at length imbued with a lateral motion. . . . . The appearance is that of a centre of calms whence currents flow in radial lines, rapidly curving to the right, and forming a sort of 'anticyclone'."

In connection with the right-handed spiral flow of such winds, in contrast with the left-handed spiral of cyclonic winds, there is a point worth noting. Galton said: "I have not the slightest doubt that a strong curvature of atmospheric currents to the right does frequently exist. Its existence is consonant to what we should expect. It is hardly possible to conceive masses of air rotating in a retrograde sense in close proximity, as cyclonolgists suppose, without an intermediate area of direct rotation, which would, to use a mechanical simile, be in gear with both of them, and make the movements of the entire system correlative and harmonious." (Proc. Royal Soc., XII, 1863, 305, 306.)



Anticyclones, as thus defined, are now known, by numerous statistical averages, to be characterized by clear weather, cold in winter, warm in summer, with weak outflowing right-handed spiral winds at the surface, while the few high-level clouds observed by Ley and others in connection with them show an inflow above; a slow descending current has therefore been in-

ferred to exist about the center of the area, and this has been confirmed by Hann's discussion of the winter inversions of temperature observed on mountain tops during the passage of such areas of high pressure. All these peculiarities are so well opposed to those of cyclones, that Galton's name seems worthy of the general acceptance that it has found. At a later date (1878), Professor Ferrel demonstrated that circular or oval areas of high pressure, with descending central currents as above described, could not exist as independent individuals; the rotary motion that must appear with such a circulation would overcome the high pressure, and produce a low pressure at the center, and as such they should be called cyclones; and this actually appears in the two great cold-center cyclones that constitute the two halves of our planetary circulation, with their centers at the poles. Persistent areas of high pressure can be only ring-shaped, enclosing cyclonic areas of low pressure by which they are produced. Such rings are seen in the great belt of high pressure around the tropics, as well as in a smaller and less distinct way around our low pressure storm centers. Professor Ferrel extended Galton's term "anticyclone" so that it should apply to these high pressure rings, and explained the occurrence of oval areas of high pressure as the result of contact or superposition of two adjacent rings, (Meteorological Researches in Report U. S. Coast Survey, 1878, Append. 10, pp. 31, 49). I believe these theoretical views have met with a very general acceptance, but still the term "anticyclone" is commonly used as Galton defined it, and this use seems warranted as well by the strongly contrasted characteristics of areas of high and low pressure, pointed out above, as by reason of priority.

Some special name is therefore needed for the rings of high pressure that Professor Ferrel described, and I would suggest that they might be called "*pericyclones*"; such a name would imply something of their form, and would associate them naturally with the low pressure cyclonic areas, which they surround and to whose formation they are due.

W. M. DAVIS.

CAMBRIDGE, May 20, 1886.

WATER-SPOUTS ON THE GULF STREAM IN WINTER.

In the Journal de Physique, Vol. 88, there is an old paper by Defranc in which he says that "he never saw a water-spout before ten o'clock in the morning, nor after five o'clock in the evening;" and that "they never appear during the night nor during the winter." This I have taken from a quotation by Professor Ferrel in his "Meteorological Researches," printed in the U. S. Coast Survey Report for 1878 (1880): and he adds, "Tornadoes and water-spouts originate only in an unstable state of equilibrium of the air, which requires an unusually rapid decrease of the temperature with increase of altitude. This can take place only when the strata nearest the earth are unusually heated, and this never occurs in the night nor during the winter, and but rarely in cloudy weather. Tornadoes and water-spouts, therefore, take place mostly if not always, in the summer season and during the day time, when it has been clear at least a short time before their occurrence." Since the publication of the essay referred to, a more careful collection of observations of water-spouts has brought to light facts which at first sight seem to contradict Professor Ferrel's theory, but which, if looked at more carefully, give additional proof to it.

From January, 1884, to March, 1886, inclusive, the Pilot Charts of the North Atlantic, published monthly by the Hydrographic Office, record the occurrence of 245 water-spouts off the eastern coast of North America from the Isthmus of Panama northward. One hundred and seventy-three or 70.6 per cent. of these were on or near the Gulf Stream between Key West, Florida, and Cape Cod, Mass. Seventy-three or 42.2 per cent. of these 173 spouts occurred during the cold months, November to March, inclusive. Inasmuch as during the time of observation—January, 1884, to March, 1886, inclusive—there are no warm months to correspond to February and March, 1886; this 42.2 per cent. is evidently larger than the cold season deserves, and if we take into account the probability of the occurrence of water-spouts for the rest of 1886, the 42.2 per cent. will be reduced to about 30 per cent., so we may conclude that about 70 per cent. of

the water-spouts reported annually for the Gulf Stream and its vicinity are in the warm months, and about 30 per cent. during the cold months. The average number of spouts for each month reported in this part of the ocean during the period referred to is as follows:

January	2⅔	May	14½	September	2½
February	11⅔	June	8	October	2½
March	7⅓	July	7½	November	1½
April	5	August	10	December	2½

And for the years to April 1st, 1886, in the same district.

	1884	1885	1886 (3 months)
Total	24	92	57
Average per month	2	7⅔	19

This yearly gain of course is not absolute, as we have no reason to suppose that the actual frequency of spouts varies greatly from year to year; it seems rather to show that the improved system for gathering reports now in vogue in the Hydrographic Office is bearing fruit. The 173 spouts are pretty evenly distributed along the coast, with 68 north of Cape Hatteras, 15 at or very near the Cape, and 90 south of it. Their position does not show a subjective grouping around any particular port, where, on account of the frequent passage of vessels, we might expect to find them most frequently observed.

Last winter it was suggested to me by Professor Davis that the winter water-spouts might, in accordance with Professor Ferrel's theory, arise in a state of unstable equilibrium of the atmosphere caused by the extension of the "cold waves," which follow our cyclonic storms during that season, out over the warm water of the Gulf Stream, and by his advice I have examined the data obtained from the monthly Pilot Charts of the North Atlantic, and from unpublished manuscript notes, supplied by the kindness of Captain J. R. Bartlett of the Hydrographic Office. The daily weather maps of the Signal Service have also been consulted for temperatures, winds, etc.

In looking at the actual conditions under which these spouts occurred, we may consider their relation to the cold waves as determined (1) by the position of the spouts as referred to the centre of low pressure areas, which they preceded or followed, (2) by the direction and strength of the winds, and (3) by the temperatures at or as near as possible to the place of their occurrence. These relations are only approximately accurate from the fact that neither the time of day nor the temperatures at the places where spouts occurred are in any case reported; the direction and strength of the winds are given only in a few cases, so that in a majority of instances we have to be content with the winds and temperatures along the coast on the dates of occurrence of spouts.

(1) The position of the spouts with respect to the centre of low pressure areas. The position of 97 spouts occurring on 60 different dates, from January, 1884, to March, 1886, inclusive, has been plotted with respect to the centre of low pressure areas. These spouts occurred during the months of August, September, October, November and December, 1884; February, March, April, May, June, July and December, 1885; and January, February and March, 1886: These were the only months during the whole period (January, 1884, to March, 1886) when dates as well as locality of spouts were recorded. During these months spouts occurred on fourteen other dates, either when there was no area of low pressure on the map, or when the spouts were so far away from the centre of the area as to render plotting with reference to it unadvisable.* Fifty-one of these 97 spouts occurred during the cold months; 36 of them were in the southwest quadrant of the low pressure area, while 15 were in the southeast quadrant. The remaining 46 spouts occurred during the warm months; 28 of them were in the southeast quadrant and 18 in the southwest. During the warm months the preference of the spouts for one quadrant or another is therefore not especially well marked; but if we look at water spouts as akin to tornadoes the excess is where we should expect to find it, namely, in the southeast qua-

*Weather maps were missing for a few dates.

drant. During the cold months the position of a large majority of spouts is directly in the area occupied by the cold wave, that is, the southwest quadrant.

(2) The direction and strength of the winds at coast stations on the Signal Service weather map (7 A. M.) as near as possible to the place of spouts recorded in August, September, October, November and December, 1884; February, March, April, May, June, July and December, 1885; and January, February and March, 1886, are summarized in the following two tables.

1884-85. WARM MONTHS: APRIL TO OCTOBER.

Velocity of Wind in miles per hour.	N.	N.E	E.	S.E	S.	S.W	W.	NW	Var	Tot.
0-10 miles..............	4	2	2	2	7	10	3	0	4	34
10-20 miles....	3	5	0	5	0	1	2	1	0	17
20-30 miles..............	0	1	0	0	0	1	0	0	0	2
Totals..................	7	8	2	7	7	12	5	1	4	53

1884-86. COLD MONTHS: NOVEMBER TO MARCH.

Velocity of wind in miles per hour.	N.	N.E	E.	S.E	S.	S.W	W.	NW	Var	Tot.
0-10 miles......	18	4	0	2	11	1	3	5	6*	50
10-20 miles..............	1	1	0	0	0	0	0	9	0	11
20-30 miles	0	0	0	0	0	0	0	4	0	4
Totals.....	19	5	0	2	11	1	3	18	6	65

*On this date there was no wind at the Signal Station nearest the place where the spouts were.

The prevailing winds during a winter cold wave are from the north, northwest and west. From the above tables we see that during the warm months only 13 out of 53 spouts occurred when the wind was in those directions, while in the cold months the order is reversed, giving 40 out of 65 spouts with the winds north, northwest or west. Here I would state that for Febru-

ary 7 and 8, 1886 "a number" of spouts was reported and this "number" has been taken as five; this does not seem to be an over estimate, inasmuch as from five to ten spouts are frequently reported in one locality on a single day. For 41 of these 65 spouts, occurring on 16 different dates, the direction and velocity of the wind at the place of occurrence are recorded, and are sumarized in the following table.

DECEMBER, 1885— MARCH, 1886.

Velocity of wind.	N.	N.E	E.	S.E	S.	S.W	W.	NW	Var	Tot.
Light	0	0	0	0	0	0	0	0	6	6
Moderate	2	6	0	1	0	0	2	9	0	20
Strong	0	0	0	0	0	0	0	15	0	15
Totals	2	6	0	1	0	0	2	24	6	41

Here too we have a majority in favor of north, northwest and west winds, but as we should expect the strength of the wind is greater than on the coast stations; this is probably due to two causes: first, there is less friction on water than on hand; and second, the winds at the Signal Service Stations were reported at 7 A. M. when the velocity is generally less than later in the day, at the hours when spouts usually occur.

In this connection it may be of interest to note the weather at the time of the occurrence of a few spouts which were better described than the rest, and also the direction and velocity of their motion.

WEATHER AT TIME OF WATER-SPOUTS IN OR NEAR THE GULF STREAM.

Date.	No.	Weather.	Wind.
Jan. 28, 1886	2	Squally; thunder and lightning.	N. N. E.
Feb. 13, 1886	6	Squally.	Variable
Feb. 19, 1886	2	Squally: lightning.	W.
Feb. 21, 1886	10	Violent squalls: hurricane.	N. N. W.
IN GULF OF MEXICO.			
Feb. 8, 1886	7	Cloudy, squally and rainy.	N. N. E.
Feb. 9, 1886	5	Cloudy, squally and rainy.	N. N. E.

MOTION OF WATER-SPOUTS IN OR NEAR GULF STREAM.

Date.	No.	Moving from.	Rate.	Wind.
Dec. 22, 1885....	1	....	25 miles an hour.	N.W
Jan. 19, 1886 ...	2	N. to S.	....	N. N.E
Jan. 30, 1886....	1	S.W " N.E	....	S.E
Feb. 10, 1886....	6	N. " S.	....	N.E
Feb. 13, 1886....	6	W. " E.	....	Variable.
Feb. 19, 1886....	2	E. " W.	....	W.
Feb. 21, 1886....	10	N.W " S.E	....	N.N.W. (Hurricane)
March 1, 1886...	8	N.E " S.W.	....	N.W
March 3, 1886...	1	....	25 "	N.W
March 24, 1886..	4	....	....	N.W

IN GULF OF MEXICO.

Feb. 8, 1886.....	7	N.E to S.W	....	N. N.E
Feb. 9, 1886.....	5	N. " S.	....	N. N.E

The most obvious fact derived from this last table is that the direction of motion in most cases is from the north, northwest or west, and this would seem to point to a state of unstable equilibrium in the southwestern part of the storm area, instead of the southeastern, as in generally the case on land when tornadoes occur in the summer season. As I have no record of the direction of motion of spouts during the warm months, it is impossible to say now whether the same preference for motion from the northwest holds good during the summer season, or whether the direction is from the southwest as we might then expect.

On February 19th the direction of the motion was a very unnatural one, and I cannot help thinking it should be reversed into west to east, inasmuch as the wind at the time is reported "from the west." On January 30th, the spouts were south-southwest of the center of low pressure; while on February 13 and 19 they were in the southeastern octant of the storm. On six of the other nine dates, they were south-southwest of the center of low pressure, and on the remaining three (February 8th, 9th and 10th) they were southeast; but these were in the Gulf of Mexico, and for the reason that the winds were north-northeast and northeast, and on account of the distribution of temperature, which will be spoken of later, it seems more reasonable to connect them with a low pressure area which had

already passed, as otherwise the more natural direction of the wind would have been southeast.

(3) The temperatures at the time of occurrence of spouts have been considered by examining the position of the isotherms on the Signal Service weather maps for twenty-three dates, on which sixty-two spouts occurred during the cold months. On seventeen of these dates there was a marked southerly extension of the cold waves as shown by the deflection of the isotherms; this was so great that in a number of these cases they were parallel to the coast, or nearly so. On one of these dates the isotherm of 20° crossed latitudes as low as northern Florida; on another, the isotherm of 30°, and on three others the isotherm of 40° reached Florida; isotherm of 10° extended into the Southern States on two of the dates, that of 30° on five dates, and that of 40° on two dates. The same deflection is true of the remaining six of the twenty-three dates, but to a somewhat less extent A relative cold along the coast is therefore a characteristic feature of dates when water-spouts have occurred. Three instances may be cited when this is especially marked. February 21st, 1885; center of low pressure on the Gulf of St. Lawrence; high pressure area in the Northwest; isotherm of 10° extending S.W. from the upper St. Lawrence to New York then nearly parallel to the coast as far south as Cape Hatteras, then W.S.W. across the Mississippi river; two spouts in Gulf Stream between latitudes of Cape Hatteras and Philadelphia. January 14th, 1886; high pressure area off the coast almost in the latitude of Philadelphia; isotherm of 20° extending across southeastern Georgia and thence to the Mississippi; four spouts off the eastern coast of Florida. February 21st, 1886; center of low pressure over Gulf of St. Lawrence, area of high pressure in the west; isotherm of 30° running parallel to the coast from Cape Hatteras to southeastern Georgia, then northwest to Lake Michigan; a few spouts in the Gulf Stream southeast of Cape Hatteras. In this connection let us look at the distribution of temperatures on February 8th, 9th and 10th, 1886, which has already been referred to under (2). On the 8th, when seven spouts occurred close south-southwest of lower Florida, the isotherm of 40° was

south of New Orleans; on the 9th, when five spouts occurred near the same place, it crossed Alabama and Georgia; and on the 10th, when six spouts occurred S.S.E. of lower Florida near the coast, the isotherm of 50° crossed the northern part of the state.

So far it seems evident that a fair majority of water-spouts in winter occur during the passage of "cold waves," as shown by their position relative to the center of low pressure areas, by the strength and direction of the prevailing winds, and by the distribution of temperatures. But we may inquire whether there are not many cold waves without water-spouts. During November and December, 1884, January, February, March and December, 1885, and January, February and March, 1886, there were about forty tolerably well marked cold waves; eighteen of these were accompanied by water-spouts. Although this is not a majority, we should, nevertheless, take into consideration the probability of the occurrence of very many spouts which are never seen, and also the much lamented fact that masters of vessels are very careless about reporting those which come under their observation. A gain of 950 per cent. in the records in two years and a quarter is however very encouraging and gives promise that in the future work of the Hydrographic Office there will be no diminution of the efficiency which it has already shown in leading mariners to make desirable observations, in collecting them promptly and in presenting them in an available form to the public.

Review. About 30 per cent. of the water-spouts which have been reported on or near the Gulf Stream, were seen during the cold months; during these months spouts generally occur in the southwestern part of the area of low pressure, which is then as a rule characterized by the "cold wave"; in the warm months there is a preference for the southeastern quadrant, which is then the part characterized by occurrence of tornadoes and thunder-storms on land. Spouts generally occur in the warm months in time of light southerly winds, but during the cold months in time of stronger northwesterly winds. The temperature in the vicinity of spouts in the cold months is generally

abnormally low. Finally, in the winter time two conditions—wind in the northwest and low temperature reaching far to the south and southeast—are accompanied by water-spouts in a sufficient number of instances forcibly to suggest the relation of cause and effect.

The alleged rarity of water-spouts in winter points to their frequency on the Gulf Stream in this season as an exceptional occurrence, not characteristic of the rest of the ocean; and this exception seems to depend on the contrasts here possible between warm waters and cold winds, which bring about the instability of atmospheric equilibrium that Professor Ferrel considered necessary for the formation of water-spouts, but which he thought was produced only in the summer time. Similar contrasts may perhaps be found on the Kuro Siwo of the Pacific.

H. B. Gibson.

Harvard College; Class of '88, June 18, 1886.

THE ORIGIN OF THE RED GLOWS.

These brilliant phenomena first began to be observed on the 28th day of August, 1883. They have continued with varying but diminishing intensity for more than two years. They first appeared in great splendor along an equatorial belt of 18,000 miles or more. They gradually extended with reduced brilliancy to the temperate zones, exciting the wonder of Europe and the United States in November, 1883.

The most conspicuous of these phenomena take place during one hour or more before sunrise and after sunset. They may be considered as a great intensifying and prolongation of common twilight sky reflections, in consequence of a recent introduction into the higher regions of the atmosphere of some kind of finely divided matter which powerfully reflects the sun's rays, especially the red. The usual order of changes is as follows:

Clouds not obscuring the view, the horizon where the sun has just set is occupied by a bright silvery luster. Above this to a height of 30° or 40° a yellowish haze fills the western sky. Although seemingly opaque and dense, the presence in it of

Venus or the crescent moon shows it to be entirely transparent. This haze rapidly changes in color and extent, ranging through greenish yellow and olive to orange and deep scarlet. As the dusk advances, orange and olive tints flush out on all sides of the sky, especially in the east. The chief body of color gathers and deepens over the sunset, rapidly developing the red. In from 20 to 30 minutes after sunset, deep scarlet has overpowered all other hues, flaming along 60° of horizon, and 10° of altitude. This rapidly sinks and intensifies. There is a dark interval above the red. The stars begin to appear. While yet the color flames low, above the dark space appears a repetition of the orange and olive hues. Seen against the night-sky, these secondary reflections or after-glows are seemingly more brilliant than the primary ones. Again the colors change and deepen into red, and after the stars are all out, and the earlier flame has sunk below the horizon, and far later than any common twilight, a vast blood-red sheet covers the west. It has been seen rising as high as 20°. As it sinks and rests low on the horizon, in the dark night sky, it precisely simulates the appearance of a remote and immense conflagration, for which it has in many places been mistaken. I have known our usual 30 minutes of twilight to be prolonged to 90, before the last glow disappeared.

In the dawn recur the same appearances, but in inverse order. In September, 1883, they were singularly impressive and even terrific, as the first low sullen incandescence rose and spread and glared among the stars, as if the very heavens were in conflagration. Then, as well as at nightfall, a marked division occurs between the night-glow and that nearest to the sun. During the earlier weeks of the display, the dark interval was often extremely distinct. One observer (*a*) described it as a "black bow." Another saw the shadow of the remote horizon sharply projected upon the under surface of the haze-canopy, but with fine serrations, probably the shadows of platoons of cumuli (*b*). Evidently at that early date the canopy of floating haze had a well-defined under-surface.

a. *Nature*, vol. 29, p. 549.
b. *Nature*, vol. 29, p. 549.

From the beginning, the upper limit of the night-glow has always been indefinite, since its light was reflected to it from the broad surface of the first glow, while the latter showed a clean shadow of the horizon from the sun itself. In general it may be said that the tropical displays of these glows at their birth during the first week in September, as far surpassed the mild glows seen world-wide in November, as the plunging surges of a tempest surpass the tripping crests of a breeze. The entire dome of sky above and around seemed to heave with billows of lurid light, as the portentous masses of color poured out of the blue, while the west outflamed in broad conflagrations.

In September, during the day, as well as after sunset, many portions of the haze-canopy were noticeable as having a wavy or rippled structure (*c*). A conspicuous object when the sun is high has been from the first the opalescent silvery glow around the sun. This occupies a circle of 25° radius or more. The outer part develops a pinkish hue, which against the blue sky shows lilac or chocolate tints. These have a singular effect when seen through rifts of cloud, as Capt. Penhallow (*d*) saw them on September 18th, 1,000 miles north-east of Honolulu. This sun-glow has been particularly discussed by M. A. Cornu in the *Comptes Rendus*, of September 23, 1884. He remarks peculiar modifications therein of the atmospheric polarization of the sun's rays. Prof. F. A. Forel has repeatedly discussed this sun-glow, which he has named (*e*) the "Cerclede Bishop," after the first observer of the phenomenon at Honolulu. Prof. Huggins found this sun-glow putting an end to his previously successful photography of the solar corona.

The height of the main body of this haze in the atmosphere has been variously estimated at from 15 to 40 miles. The present writer, as the result of much and early observation, has no doubt that in the early part of September, 1883, no part of its under surface was less than 30 or 40 miles above the ground. All estimates should be based upon the first reflections, and not

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c. ***Nature***, vol. 29, p. 174.
d. ***Nature***, vol. 29, p. 174.
e. ***Archives des Sciences physiques et Naturelles***, tome 13, p. 465.

upon the secondary glows. No decisive tests of the nature of this reflecting matter have been secured. The spectroscope has distinctly indicated the presence of large quantities of aqueous vapor (*f*), accompanied by other peculiar influences. Fresh fallen rain and snow have repeatedly yielded a dust of microscopic particles possessing the same constitution as the fine ash-fall from Krakatoa.

The most generally accepted theory of the source of this new matter in the sky, attributes it to the great eruption of the crater of Krakatoa or Krakatao, in the Straits of Sunda, on the 27th of August, 1883, one day before the first definite record of red glows, which were seen on the 28th, at both Mauritius and the Seychelles, 3,500 miles west of Krakatoa. Before considering the evidences in support of this theory, notice needs to be taken of two other hypotheses, which have been advocated.

One of these assumes the meeting of our globe with some cosmic cloud of impalpable dust, which was arrested in the upper strata of the atmosphere.

The other hypothesis supposes the cosmic cloud to have been composed of hydrogen, which united with the oxygen of the atmosphere to form the aqueous vapor evidently constituting so considerable a part of this haze.

The latter hypothesis seems open to the objection that such uniting of the two gases is usually attended with active combustien, none of which was observed.

Both hypotheses suffer from the total absence of evidence that any such cosmic cloud did approach the earth on or before August 28th, or siuce that time. The matter actually introduced into our atmosphere is brilliantly conspicuous in the sunlight. Yet we are asked to believe that a vast nebula of such matter approached unseen and enveloped the earth. In 1861, the tail of an immense and brilliant comet actually swept the earth. Yet so tenuous was the impinging matter that no traces of its presence were left behind. A cloud sufficiently dense to create the present haze, must in its approach have presented the aspect of

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f. C. Michie Smith, *Nature*, vol. 29, p. 28.

a most compact and refulgent body. So far from being possibly unobserved, it must have terrified mankind.

Another and most serious objection lies in the original narrow localization of this haze in an equatorial belt. It is difficult to conceive of a cosmic cloud possessing a mass adequate to the immense effects produced, which should not occupy such dimensions as to completely envelop the globe at once, producing glows simultaneously all over the earth, not to consider the improbability that the course of such a dense little nebula after collision should precisely coincide with the equator. It must be remembered that stray cometary or nebulous matter (not solid meteors) afloat in cosmic space, since it possesses small mass and feeble centripetal force, necessarily assumes immense volume and extreme attenuation, compared with which this haze is solidity itself. The entire quantity of this peculiar matter actually diffused in our atmosphere, must originally have been equivalent to many cubic miles of solid matter, which represents a volume of cometary material immensely exceeding the dimensions of the largest planet. The actual localization of the first glows in the tropics thus precludes reference to cosmic sources, and compels us to seek a terrestrial one.

Many have felt that the long protracted continuance of this haze in the air necessitates the supposition of renewed supplies from fresh sources, as if perhaps the earth were continuing to traverse successive regions of cosmic vapors, (which no one has seen). Had there been but one original introduction of the haze, must it not long since have been precipitated and disappeared? But we have to consider how slow is the subsidence of even coarse common dust, especially in currents of air. The haze matter in question had probably 40 miles to fall. If only 20 miles or 105,600 feet, it must fall 144 feet in a day to reach the ground in two years. It seems improbable that these ultra-microscopic particles could descend at one-tenth of such a velocity? (*g*) It seems likely, on the contrary, that the finer particles of this matter will continue suspended and produce their glows for many years to come.

g. John Le Conte, *Nature*, 29, 404.

Leaving these nebulous imaginings, let us pursue the plain, if humble, historical method of inquiry. When and where were these phenomena first observed? Under what peculiar conditions and with what attendant circumstances did they appear? In what successions of time and place did they first occur, and to what actual point of origin on the earth's surface may they be traced?

Pursuing this indispensable method of physical investigation, we find that the earlier appearances of the sunset glows, were as a rule immediately preceded by a peculiar veiling and discoloration of the sun's disc, commonly termed the "Green Sun." While the sky was cloudless, or faintly obscured by undefinable haze, the disc of the sun was described (*h*) as pallid, livid, bluish, coppery, greenish, "bird's-egg hue," "plague-stricken." It could be directly viewed with the naked eye, and its spot distinguished. At the altitude of 40° the sun generally resumed its ordinary aspect, but again turned pallid and green as it descended in the west. In some cases the sunset glares immediately succeeded, while in others they were not reported, the haze probably having been too dense for the sun's rays to penetrate it obliquely, so as to be reflected from its under surface. The first appearances of the red glows were so intimately associated with the green suns that it is impossible not to treat them as different aspects of one and the same phenomenon.

It seems in place here to cite Mr. Whymper's observation (*i*) of green sun and wonderful sky-glows combined. On the third of July, 1880, on the upper slopes of Chimborazo, Mr. Whymper witnessed an eruption of Cotapaxi, smoke from which drifted over the observer's position. Seen through it, the sun's disc assumed a peculiar green, while the changing colors of the sky "surpassed in vivid intensity the wildest effects of the most gorgeous sunsets."

From such records as were accessible, I have constructed the accompanying tabulated statement of the earlier recorded ap-

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h. Nature, 28, *pp*. 576, 577—*Vol*. 29, *pp*. 28, 76, 133, 181, 549.

i. Nature, 29, *p*. 199.

pearances of the green suns and the red glows. The latitude and longitude of each locality are given in the table, with the date of the first appearance of the phenomenon at each point. The distance from Krakatoa is estimated in English miles, the number of hours in transit and the velocity of the current calculated. The source of information is specified for each of the seventeen different localities, three of which were on vessels at sea in the Pacific. To these, Maranham might be added. I lack the needed reference. At six of these localities, both the green sun and the red glows were reported as having been seen on the same day. At four points only red glows were reported, and at seven only green suns.

The most remarkable fact evidenced by this table is that the earliest appearances of these phenomena are thereby traced along a line of points, successive from east to west, lying very near the equator, beginning at the Seychelles Islands in the Indian Ocean, and running thence in successive days through Cape Coast Castle, Trinidad, Panama, and Fanning's Island, arriving at Strong's Island on September 7th, having traversed a great circle for 17,600 miles in about 230 hours.

It thus appears that the original haze cloud, which first produced the red glows, swept west from the Indian Ocean in an equatorial stream or belt, which traversed more than two-thirds of the circumference of the globe at an average velocity of nearly eighty miles an hour. A precise estimate of its velocity between successive points is prevented by the imperfection of the observations made. The date at Cape Coast Castle is uncertain by one day. The dates at Seychelles and Mauritius are probably vitiated by the copious diffusion of volcanic smoke prior to the regular movement of the upper stream. It seems quite clear, however, that an average velocity of about 90 miles an hour during the first half of the course of this haze-stream became reduced to about 60 miles in its later stages. These data appear to favor the conclusion of Mr. S. E. Bishop, (*j*) that a stream of vapors was discharged over and upon the upper surface of the atmosphere of the Indian Ocean, by a powerful *initial* impulse,

j. *Hawaiian Monthly, April*, 1884.

LOCALITY.	LAT.	LONG.	DATE.	DIST.	HRS.	VELOC.	GREEN SUN.	RED GLOW.	REFERENCE.
Krakatoa.........	6° 10′ S.	105° 30′ E.	Aug. 27th, A. M.						
Mauritius........	20° 20′ S.	57° 40′ E.	" 28th, P. M.	3,600	30	120		R S.	*Nature*, Vol.30, p. 279
Seychelles........	4° 30′ S.	55° 20′ E.	" 28th, P. M.	3,480	30	116	G. S.	R. S.	" " 30, 280
Cape Coast Castle.	5° 25′ N.	1° 15′ W.	Sept 1st, A. M.	7,420	90	82	G. S.		" " 29, 133
Trinidad.........	10° 30′ N.	61° 26′ W.	" 2d, A. M.	11,600	127	91	G. S.	R. S.	" " 28, 577
Barinas, Ven.....	7° 44′ N.	70° 22′ W.	" 2d, A. M.	12,220	128	96	G. S.		" " 29, 76
Panama..........	9° — N.	79° 35′ W.	" 2d, A. M.	12,860	128	100	G. S.		" " 29, 152
C. S. Hurlburt....	17° — N.	125° — W.	" 3d, P. M.	16,000	201	80		R. S.	" " 29, 549
Fanning's Island.	2° 40′ N.	159° — W.	" 4th, P. M.	18,400	218	84	G. S.		" " 29, 549
Jennie Walker....	8° 20′ N.	155° 25′ W.	" 4th, P. M.	18,200	218	84	G. S.	R. S.	" " 29, 549
Zealandia........	5° — N.	163° — W.	" 5th, A. M.	18,800	230	82	G. S.		" " 29, 181
Maalaea..........	20° 49′ N.	156° 28′ W.	" 5th, A. M.	18,300	229	80		R. S.	" " 29, 573
Honolulu.........	22° 17′ N.	157° 52′ W.	" 5th, P. M.	18,400	241	76	G. S.	R. S.	" " 29, 174
Strong's Island...	5° — N.	162° — E.	" 7th, (6) P. M.	21,100	256	83	G. S.		" " 30, 537
New Ireland.....	5° — S.	152° — E.	" 1st, P. M.	3,200	107	30		R. S.	" " 29, 259
Madras...........	13° 13′ N.	80° 12′ E.	" 10th, A. M.	1,900	332	6	G. S.	R. S.	" " 29, 28
Ongole...........	15° 32′ N.	80° 8′ E.	" 10th, P. M.	1,900	342	6	G. S.	R. S.	" " 28, 576
Soudan...........	15° — N.	32° — E.	" 24th.	5,100	672	8	G. S.		" " 29, 181

which drove it straight in a great circle, independently of atmospheric currents, and that this stream gradually suffered retardation as it descended into the atmosphere, finally ceasing over the Caroline Islands.

Without necessarily accepting this writer's theory, showing how such an impulse would be generated by the rotation of the earth, it seems clear at least, that the inception of the equatorial haze-stream, and its attendant glows has been traced with positive certainty as far as the western side of the Indian Ocean, and back to the 28th day of August. Eastward of this, our search is arrested by a vast pall of volcanic smoke proceeding from the greatest eruption described in history. But if we stretch our line back through this obstructing veil, 30 hours in time and 3,500 miles in distance, we find ourselves confronted by the great final explosions of Krakatoa on the morning of August 27th. Projected aloft from this crater by a succession of colossal explosions, a vast dome or cone of volcanic smoke on that day covered a region of not less than 400 miles in diameter with absolute darkness for many hours, and spread a deep gloom for not less than 1,000 miles in every direction. From the summit of this immense reservoir of vapors piled to an unknown height, the great equatorial haze-stream, appears to have issued, and sped westward around the globe. We have unquestionably traced it to its source in the vapor-mass that overhung the Indian Ocean less poetic than a cosmic nebula, but possessing reality, and with it have found the one sole and indisputable origin of the red glows which attended its course.

This does not imply that the swift equatorial smoke-stream embodied the whole of the glow-producing medium. It seems more probable that the larger portion of the vapors which became slowly and irregularly diffused over the globe during the ensuing seventy days, were drifted from the broad vapor-mass after the special stream had ceased. Thus we find the Indian peninsula untouched by the narrow stream which must have passed south of the equator. But fourteen days afterwards, the haze arrived in full force and produced the green suns and red glows throughout Ceylon and Southern India, shortly afterwards

appearing in Aden and the Soudan. We also find the glows at New Ireland, 3,200 miles due east from Krakatoa, in four days after the last explosions. In all these cases the transportation was comparatively slow, and probably due to atmospheric currents.

We need to consider the adequacy of the eruption of Krakatoa to have produced atmospheric effects of such magnitude and extent, not only "*belting* the globe with flaming skies," as in September, but by November enveloping the entire sphere in these fiery glares. Can Krakatoa be shown to have probably ejected a *quantity* of tenuous matter sufficient for this result? And can it be believed to have delivered such matter at such a *height* that in its descent it would form a haze canopy from 30 to 40 miles above the surface?

We have absolutely and precisely traced the Glows to their source, and so have the right to affirm that Krakatoa proved its colossal capacity to emit these vapors in such quantity and to such a height, by having actually done so. It is the objector's part to prove that it could not have done so, and did not. But waiving this advantage, we cite a preliminary official report on the nature and effects of the eruption of Krakatoa, made by Mr. R. D. M. Verbeek (*k*). He makes an estimate of the quantity of those solid ejecta crater, which were so coarse as to be speedily precipitated. This amounted to 18 cubic kilometers, or 4.5 cubic miles, two-thirds of which fell as ashes and pumice within a radius of nine miles. He believes that at least an equal mass was delivered at the highest parts of the column in the form of vapors and impalpable dust. It would be easy to present considerations to show that this finer portion must have vastly exceded the coarser. But this might be speculative. We know that four and a half cubic miles of solid matter would overlay the entire atmosphere of the globe with a solid film of one seven-hundredth of an inch in thickness. This would doubtless be equivalent to many miles in thickness of such tenuous vapor and dust as have been floating in the upper ether.

[TO BE CONTINUED.]

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k. *Nature*, vol. 30, pp. 10–14.

REPORT OF DR. LEONARD WALDO, SUB-COMMITTEE OF SECTION XXII, ON THE EXHIBIT OF METALLIC THERMOMETERS MADE BY THE STANDARD THERMOMETER COMPANY, OF PEABODY, MASS.*

The limitations of mercurial and other thermometers are felt in many of the processes of the arts. The boiling and freezing points of mercury being so near together, and the nature of glass rendering it so fragile, and so liable to softening near the boiling point of mercury, combine to render some substitute for the mercurial thermometer highly desirable in many cases.

Your committee, therefore, with your consent, decided to give as thorough an examination into the performance of the metallic thermometers exhibited, as the limits of an extemporized laboratory would allow.

The exhibited thermometers consisted essentially of a coiled cylindrical spiral, the material of which was composed of laminated brass and steel, united by silver solder.

This cylindrical coil is about 1.5 inches long, about .6 of an inch in diameter, each coil having a width of .1 inch, and making about twelve turns throughout its length. A change of temperature will, of course, cause an extension of a free end of such a coil, and this extension is magnified by a rack and pinion, which gears the indicator to the free end of the coil.

As constructed by this company, the apparatus is simple, the adjustment of the hand which serves as an indicator, and which moves over a circular dial, is easily affected, and your committee is of the opinion that the indications would be consistent with themselves permanently, so far as liability to get out of adjustment is concerned.

The hand which serves as the temperature indicator, moves over a clearly graduated dial, and the entire instrument is cased in a metallic box, and made to hang in any position.

Two metallic thermometers were selected for careful examination; they were marked Nos. 22 and 23. The hands moved over the dials smoothly, without hitching and in the open air had

*Reprinted from the journal of the Franklin Institute.

the usual agreement with mercurial thermometers hung in neighboring positions which is expected of reputable mercurial thermometers.

A water-comparator consisting of a rectangular box holding several gallons of water and provided with heating and stirring arrangements was rigged up in a neighboring building, and the two metallic thermometers were immersed in the water in connection with a number of precision thermometers. After a thorough agitation of the water, the thermometers were read in such a series that the observer began at the left hand end of the row of thermometers standing in the comparator and read to the extreme right. Then making a second reading at the extreme right, the thermometers were then read in an inverse order· The times at the beginning and end of the entire series being noted and the intervals between the readings of the thermometers being practically the same, it is assumed that the means of the thermometer readings correspond to the mean of the observed times.

This is not rigorously true, since the radiation coefficient of the comparator and of the thermometer is not taken into account. Its accuracy is in keeping with the general accuracy to be attained in such apparatus as we were able to devise during the exhibition. Professor Harrington made the record, and occasionally verified the thermometer readings. Professor Rogers was present during a part of the test.

The standard thermometers inserted in the comparator consisted of two short standards made by Hicks, of London, graduated to $\frac{1}{2}°$ Fahrenheit, 1° F. = 1.8 mm. The first thermometer of the two readings up to + 40° F., and the second reading to + 103° F.

These corrections of these standards were determined by comparison with the Yale College Observatory standards to be at

Degrees F.	*Degrees F.*
32	0.0
52	0.0
72	+ 0.1
92	0.0

A third standard introduced was one of the standards issued

by the Yale Observatory, graduated in C. degrees to 1-5° C., and having 1° = 4.7 mm. It is marked "Yale Observatory Standard 53.," and I am indebted to Mr. O. T. Sherman, of the Yale Observatory Thermometric Bureau, for the following system of corrections to be applied to its scale.

Degrees C.	*Degrees C.*
0	—0.04
5	—0.007
10	+0.043
15	+0.028
20	+0.016
25	+0.025
30	+0.073
35	+0.130
40	+0.074

The following observations were made:

Observed Readings of the Standard Mercurial Thermometers: "W. O. I.," "W. O. II.," "Y. O. 53,' in a Water Comparator with the Metallic Thermometers marked "No. 22 and No. 23."

Date and Time of Comparison.	Reading of W. O. I.	Reading of W. O. II.	Reading of Y. O. 53. (Centigrade.)	Reading of No. 23.	Reading of No. 22.	Y. O. 53, reduced to Fahr.	Y. O. 53, correction in Fahr. degrees.	W. O. I. and W. O. II., correction.
1885. October 3d. *h. m.*	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.
1 { 12 47·8	26·9	....	— 2·55	27·8	27·0	27·41	....	....
12 51·1	27·1	....	— 2·50	27·8	27·1	27·50	— 0·06	0·0
2 { 12 53·4	27·05	....	— 2·60	27·9	27·1	27·32	....	....
12 56·9	27·15	....	— 2·60	27·9	57·1	27·32	....	....
3 { 12 58·8	27·15	....	— 2·50	28·1	27·3	27·50	....	....
1 2·2	27·35	....	[— 2·20]	28·2	27·3	[28·04]	....	....
4 { 1 3·8	27·4	....	— 2·40	28·2	27·6	27·68	....	....
1 7·2	27·5	....	— 2·40	28·2	27·6	28·68	....	....
5 { 1 10·4	27·6	....	— 2·15	28·3	27·6	28·13	....	....
1 14·2	27·55	....	— 2·35	28·3	27·6	27·7	....	....
6 { 1 35·9	....	38·25	+ 3·55	39·20	38·70	38·39	....	....
1 39·7	....	38·38	+ 3·60	39·20	38·70	38·48	+ 0·08	0·0
7 { 2 5·1	....	68·80	20·40	70·5	68·9	68·72	....	....
2 10·2	....	68·70	20·40	70·6	68·9	68·72	+ 0·03	+ 0·1
8 { 2 16·5	....	68·60	20·34	70·3	68·7	68·59	....	....
2 20·1	....	68·55	20·30	70·3	68·7	68·54	....	....
9 { 4 11·9	....	89·40	31·65	91·9	89·0	88·97	....	....
4 14·7	....	89·10	31·60	91·9	89·0	88·88	+ 0·13	0·0
10 { 4 15·2	....	89·10	31·60	91·9	89·0	88.88	....	....
4 18·5	....	89·05	31·55	91·9	89·0	88·79	....	....
11 { 4 19·0	....	89·00	31·53	91·9	89·0	88·75	....	....
4 20·3	....	89·05	31·50	91·9	89·0	88·70	....	....
12 { 4 54·2	....	69·05	20·60	72·3	69·2	69·08	....	....
4 56·2	....	69·05	20·63	72·3	69·2	69·13	+ 0·03	+ 0·1
13 { 4 57·2	....	69·05	20·60	72·3	69·1	69·08	....	....
4 50·0	....	69·05	20·62	72·3	69·1	69·12	....	....

Taking the means of each set, and applying the corrections indicated in the last two columns, we have the following table showing the corrected standard readings in Fahrenheit degrees as compared with the readings of the metallic thermometers, Nos. 23 and 22:

Number of the Pair.	Mean of the Times.	Mean of the W. O. Thermometer in Fahr.	Mean of Y. O. 53 in Fahr.	Corrected Mean W. O. Thermometer.	Corrected Mean Y. O. 53.	Mean of the Mercurial Standards.	Mean of No. 23.	Mean of No. 22.
	h. m.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.
1.	12 49·4	27·00	27·45	27·00	27·39	27·20	27·80	27·05
2.	12 55·2	27·10	27·32	27·10	27·26	27·18	27·90	27·10
3.	1 0·5	27·25	[27·50]	27·25	27·44	27·35	28·15	27·30
4.	1 5·0	27·45	27·68	27·45	27·62	27·54	28·20	27·60
5.	1 12·3	27·57	27·91	27·57	27·85	27.71	28·30	27·60
6.	1 37·8	38·31	38·43	38·43	38·51	38·47	39·20	38·70
7.	2 7·6	68·75	68·72	68·85	68·75	68·80	70·55	68·90
8.	2 18·3	68·57	68·57	68·67	68·60	68·63	70·30	68·70
9.	4 13·3	89·25	88·92	89·25	89·05	89·15	91·90	89·00
10.	4 16·8	89·07	88·83	89·07	88·95	89·01	91 90	89·00
11.	4 19·7	89·03	88·72	89·03	88·85	88·94	91·90	89·00
12.	4 55·2	69·05	69·10	69·15	69·13	69·14	72·30	69·20
13.	4 58·1	69·05	69·10	69·15	69·13	69·14	72·30	69·10

From the above we readily deduce the corrections to be applied to Nos. 23 and 22 to reduce their face readings to the true temperature of the comparator as follows:

Number of Observations.	Point of Ther. Scale F.	Correction to No. 23.	Correction to No. 22.
	degrees.	degrees.	degrees.
5	27·4	— 0·65	+ 0·09
1	38·5	— 0·73	— 0·23
2	68·7	— 1·71	— 0·08
3	89·0	— 2·87	+ 0·03
2	69·1	— 3·16	+ 0·04

Analyzing the above results, we see that No. 23 fails to return to its agreement with the mercurial thermometers at 70°, after it had been compared at 90°, by 1·4°.

No. 22, however, shows a remarkable agreement with the scale of the mercurial thermometers both ascending and descending. With the exception of its deviation at 40°, which is still less

than $\frac{1}{4}°$ F., there seems to be no deviation of its scale as great as ·1° F. This, for commercial purposes, is a practical agreement with the perfect mercurial thermometer at ordinary temperatures.

It is not improbable that the coincidence extends in practical agreement with the Fahrenheit scale to some degree above the point of boiling water. On this point, however, your committee has had no opportunity to satisfy itself.

The instruments impressed your committee with their neatness of design and legibility of dial. They seemed peculiarly appropriate for ordinary air temperature use, and have the merit of revealing the temperature at a glance from any point of an ordinary sized room. Your committee was informed that display thermometers of large size were prepared by the same company which were legible at half a block's distance.

Respectfully submitted,

LEONARD WALDO,

Sub-Committee of Section XXII.

CORRESPONDENCE.

ANCHOR-ICE.

TO THE EDITOR:—Noticing an article in the March number of the METEOROLOGICAL JOURNAL on anchor-ice, I wish to state some of my observations on the same, as they possibly may throw some light on the subject.

During the day time it only forms in cloudy weather, and disappears as soon as the atmosphere clears, even if the temperature is sinking. In cleaning a driftgrate in front of a waterwheel penstock with a rake, I have often noticed innumerable small pellets coming to the surface, soon afterwards anchor-ice would form on the grate bars, and if the atmosphere did not clear would form around the turbine.

During the night it often forms while the atmosphere is clear, but only when large quantities of snow have melted during the day time, and the temperature is sinking after sunset.

But the greatest formation of anchor-ice takes place when during the day time in a blizzard, or with a strong wind heavy masses of snow are blown into the open water, and the temperature still further sinks after sunset. Under these circumstances an iron turbine under ten feet of water has often become so incased with anchor-ice as to come to a complete stand-still.

I also observed that closely packed drifting ice on larger streams will freeze together so that the whole mass will come to a stand-still only during cloudy weather. I noticed this more particularly on the river Rhine in Germany. This phenomenon may have some connection with anchor-ice.

M. MEINHARD.

TROY GROVE, ILLINOIS.

WEATHER RULES IN GERMANY (BAUERNREGELN).

TO THE EDITOR:—There are a great many weather rules in vogue amongst the peasantry of Germany. The most of them are founded on superstition, or religious phantasms, and therefore are unworthy of any future consideration. Still, some of them seem to be founded on long and close observations, although science fails at present to satisfactorily explain the same.

One of these rules says: "A fog in March, a frost in May," another, to the direction the wind blows on "January 25th, the magpie (Elster) will close his nest." The meaning being that the wind and storms will be mostly from this direction during the season.

According to my memory, these rules always held good in Germany, but memory is not sufficient to establish facts. On March 15th of the present year there was a heavy fog on the night of May 15th to May 16th, one day before the full of the moon, there was a hoar-frost, thermometer 35° Fahrenheit. This led my attention again to this old rule, and as a correct record of the weather for the past eleven years is at my service. I extract the following facts in regard to these rules.

1875.—Jan. 25. Wind N. W., prevailing wind during the year N. W. Medium thermometer 47°. March 13th fog. Some snow

on May 1 and 2, and frost on May 16th. Thermometer, 33° four days before the full of the moon.

1876.—Jan. 25. Wind S. W., prevailing wind during the year S. W. March 3, a fog. May 1, a hoar-frost. Thermometer 42°, seven days before the full of the moon.

1877.—Jan. 25. Wind N. E., prevailing winds during the year N. E. to S. Medium thermometer 52°. March 12, a very light fog, no frost in May.

1878.—Jan. 25. Wind S. W. to E., prevailing winds during the year the same. Medium thermometer $53\frac{1}{4}$°. March 13 and 23, fogs. May 13, 15, 22, hoar-frosts. Thermometer 38°, 37°, 48°.

1879.—Jan. 25. Wind S. W., prevailing winds during the year S. W. Medium thermometer 51°. March 27, fog. May 1, frost. Thermometer 33°, five days before the full of the moon.

1880.—Jan. 25. Wind S., prevailing wind during the year S. to N. E. Medium thermometer 52°. No fog in March nor frost in May.

1881.—Jan. 25. Wind W., prevailing wind during the year S. and S. W. Medium thermometer $51\frac{2}{3}$°. March 10 fog and hoar frost. May 3, hoar frost. Thermometer 40°, three days before first quarter of the moon.

1882.—Jan. 25. Wind S. to N. E. Medium thermometer $50\frac{1}{3}$° March 15 and 26, foggy. May 15, hoar-frost. May 25, snow.

1883.—Jan 25. Wind N., prevailing wind in the year N. E. Medium thermometer 48°. No fog in March, nor any frost in May.

1884.—Jan. 25. Wind S. Medium thermometer 48°. No fog in March, but heavy on March 4. A light hoar-frost on May 16. Thermometer 35°, one day before last quarter of the moon.

1885.—Jan. 25. Wind S. W., prevailing wind during the year S. W. Medium thermometer $45\frac{1}{2}$°. March 14, fog. May 7, frost. Thermometer 32°, last quarter of the moon.

1886.—Jan. 25. Wind S. W. March 15, a heavy fog. May 16, hoar-frost, two days before the full of the moon.

This observations seem to leave no doubt that the above rules are based on facts. I also find that a frost in a clear and moon-

light night has not the destroying effect on vegetation than the same frost would have in a dark and moonless night. Notwithstanding the fact that the finest and most accurate instruments fail to show any difference in the temperature.

M. MEINHARD.

TROY GROVE, ILLINOIS.

LITERARY NOTES.

SYMON'S MONTHLY METEOROLOGICAL MAGAZINE. Vol. XX, Nos. CCXXXI-CCXXXIX, April to December, 1885.

(18) **A floating mid-Atlantic meteorological observatory,** pp. 33-35, 52-54. This articles urges the importance to English weather prediction of a telegraphic station in the mid-Atlantic. A patent has been taken out by Mr. C. W. Harding for a vessel to be used as a floating light ship, of such shape that the waves will be deflected under her and safety in high seas thus ensured. A vessel of the proposed circular pattern has already been used in watching large fisheries and it is claimed to be able to outride the heaviest gales. The same project has recently been discussed in an article entitled "Ocean lightships" in the *New York Maritime Register* for February 10, 1886; after a review of the value of such lightships to disabled vessels and shipwrecked mariners as well as for meteorology and storm warnings, a fair and exhaustive trial is advocated.

(19) **Notes** on the weather of a century ago. Charles Tomlinson, pp. 50-52. Extracts from letters of the poet Cowper contain complaints of cold summers and severe unseasonable weather at all times of the year. Icebergs are charged with producing much of their bad weather.

(20) **Atlantic tides as storm warnings,** pp. 54-55, 80-89. Mr. G. W. Brennan communicates the statement that the action of the tides above or below the normal on the Atlantic coast is an indication of the approach of cyclones. In the extreme islands of the West coast of Scotland, the inhabitants consider it a well established fact that the waters of the Atlantic rise abnormally high for forty-eight hours and downwards before the arrival of a cyclone. Mr. Brennan believes that a more valuable means of storm prediction is to be found in this tidal action than in the prevailing system of isobars and gradients. Mr. Henry Muirhead attributes the phenomenon to the effect of reduced pressure causing a rise in the same manner as in a pump when the piston is raised. Mr. Brennan does not accept the explanation since the rise of the water above the normal takes place far in advance of the fall of pressure.

(21) **M. Herve-Mangon's iron tower,** pp. 65-67. A description and

engraving of the tower erected by M. Hervé-Mangon especially to obtain an exposure for anemometers and thermometers free from the effect of the earth's surface. It is fifty feet in height and made of angle-iron bolted together and painted white. Angle-iron is used as giving a maximum strength combined with the object of ensuring that thermometric observations shall not be vitiated by the mass of the tower. As a result of these endeavors, it is found that even in full sunshine, the iron is not 1° Fahrenheit warmer than the surrounding air. Internal ladders provide means of ascent and the whole tower might be taken as a pattern for a standard exposure.

(22) **Frozen ground at Yakoutsk**, pp. 69–71. On the basis of temperature observations down to 540 feet, Prof. J. D. Everett computes that the ground must be frozen as far as 706 feet, the gradient being 1° F. in 52 feet.

(23) **Scintillation and weather forecasting**, pp. 81–86. An historical resumé of the work done by Prof. C. Dufour and by M. Montigny in observations of the scintillation of the stars. The latter has conducted observations with an apparatus designed by himself by which the phenomenon is claimed to be accurately measured. A series of observations for fourteen years forms the basis of a paper showing the relation between the variation in scintillation and the conditions of the atmosphere. M. Montigny finds that the scintillation increases with decrease of temperature, on the approach of rain, before the advance of a cyclonic depression, and, in general, with increasing humidity. He concludes that the amount of water in the atmosphere chiefly regulates the frequency of scintillation and that, therefore, the scinti-ometer becomes an important instrument for weather prediction.

(24) **Atmospheric electricity**, pp. 89–90. A clipping from the *English Mechanic* gives some of the results obtained by Prof. Palmieri of the Vesuvian Observatory. He finds that there is a maximum of atmospheric electricity at 9 A. M., and another soon after sunset; a minimum occurs before daybreak and another in the afternoon. This periodicity is, however, disturbed by atmospheric movements. The assumption that atmospheric electricity becomes stronger with altitude is not borne out by the Vesuvian observations.

(25) **Another drought**, pp. 97–98. The editor states that in nine successive years, 1875 to 1883, July had been wetter than the average. This unprecedented series of wet summers was followed by a deficient rainfall in 1884 and again by a severe drought in July, 1885, extending over all portions of the British Isles.

(26) **J. Rand Capron.** *Atmospheric electricity*, pp. 105–106, 134–135. Electrical observations have been made at Guildown with the following

apparatus. Collectors are used consisting of carefully insulated rods terminated in a corona of platinum tips and exposed at different elevations. Copper conducting wires covered with gutta-percha connect the collectors with pith ball and with gold leaf electrometers in the observatory. A Thomson quadrant electrometer is also used for measuring the intensity and duration of current. Comparative experiments with a water dropper and the platinum points show that the former is a much more sensitive collector. Mr. Capron finds that wind is a strong excitant of electricity and that strata of air showing opposite electricities may co-exist at different elevations above the earth's surface. On one occasion for a quarter of an hour during the approach of a snow-storm the points near the ground were charged positively while points on the tower were charged negatively.

(27) **Meteorology at the Inventions Exhibition**, pp. 113-120. A catalogue of the meteorological instruments displayed at the exhibition with comments upon the more noteworthy inventions. The following description is given of the construction of Denton's *unalterable thermometers*:—"I construct the thermometers with supplementary chambers so that they will bear heating to over 150° F. above the highest point that they are intended to be used at. I then subject them to this extra temperature in heated oil for three weeks." Mr. Denton also states that the rise in the zero point has not been due to contraction of the tube but to expansion of the mercury.

(28) **The drought of July, 1885**, pp. 120-123. Extracts from letters of observers throughout England give graphic accounts of the extraordinary drought.

(29) **J. Rand Capron.** *The rainband vindicated*, pp. 129-132, 145-152. The author gives an account of the development and present status of rainband spectroscopy with a review of the recent literature on the subject. The need of a micrometer or gauge for measuring the rainband is expressed, but no mention is made of the apparatus devised by Prof. C. S. Cook (Science II, 488) for accomplishing this object. A contribution to the same end has also been made by Mr. L. Bell, (American Journal, Science, November, 1885.) Mr. Capron maintains the value of the spectroscope for predicting rain and presents a month's observations giving the observed rainband and the following weather. A large proportion of the observed rainbands were verified by rain following, but the number of days on which the rainband must have been verified by rain falling at the time of observation is not stated. No information is given as to the average number of hours elapsing between the prediction of rain from the observation of the rainband and its occurrence. Observations made in the United States indicate that the time between the attainment of a rainband of sufficient intensity to indicate rain and the

beginning of the rain is frequently so short as to impair its predictive value.

(30) **The climate of the British Empire during 1884**, pp. 136-137, An annual climatological table is given for fourteen stations scattered throughout the British empire. Adelaide heads the list with the highest maximum temperature, 110.2°, and Winnepeg closes the list with the extreme of cold, —44.5°. The largest annual rainfall is 82.1 inches at Colombo, Ceylon, and the smallest is 18.0 inches at Malta.

(31) **Stanford's County Atlas and Handbook of England and Wales**, 8 vo., 330 pp., 89 maps, London; pp. 153-154. This is a notice of a valuable atlas. In its 89 maps it contains excellent graphical presentations of a large number of different subjects—Geography, Geology, Climate Population, Industries, Agriculture, and many other physical and statistical features of the kingdom.

(32) **The Climate of Crowborough Hill, Sussez.** By C. L. Prince. 8° 1885. This is a review of an interesting monograph on local climate that contains much material of general interest. Students of thermometer exposure will find in this book many pages devoted to full abstracts of observations made with thermometers exposed in a Stevenson screen and in the free air without covering. A bright bulb thermometer exposed in the free air, four feet above the ground, had an average daily maximum, even in July, only 5.7° higher than that in the Stevenson screen. The reviewer finds the explanation of this small difference entirely in the conditions of the unsheltered thermometer, but observations in this country have indicated that the maximum temperatures in a Stevenson screen may frequently be considerably higher than the true air temperature.

(33) **The Biela Meteors**, pp. 162-165. This article contains accurate observations from Messrs. J. R. Capron and M. F. Ward, and a summary of all information relative to the time of maximum frequency, rate of increase and decrease, magnitude and number counted. G. E. C.

(34) **Roumainan Meteorological Society**. The numbers of the official bulletin for the months, August to December, are at hand. They contain the monthly summaries of observations at Bucharest by Dr. Hepites, and other studies of interest to students of agriculture and commerce.

(35) **Smithsonian Report for 1884**. Washington, 1885. Octavo, 904 pages. The records of scientific progress, given annually in this report, are made by competent authority and are of high interest and value. Not the least important, from a general point of view, and most important to the readers of the journal, is the report on meteorology by Professor Abbe. It is the longest report in the volume, and fills 156 pages. It is the best abstract of current meteorology which appears, and every student of the science would find it of great value to him.

(36) **S. S. Bassler,** *The Weather-Chart, with Explanation of Weather prediction.* Illustrated. Cincinnati, 1886. Duodecimo, 24 pages. This is a simple explanation of the principles of weather-forecasting as now practiced, with illustrative charts. It should be in the hands of those not familiar with these principles, and can be obtained of the author at ten cents per copy. Mr. Bassler issued for a few weeks a *Weather Journal* in which were published the weather-maps from day to day. It was a useful publication and it is very much to be regretted that insufficient support obliged him to suspend it. H.

(37) **W. J. van Bebber.** *Handbuch der ausuebenden Witterungskunde.* Geschichte und gegenwartiger Zustand der Wetterprognose. I Theil. Geschichte der Wetterprognose. Stuttgart, 1885, Octavo, 392 pp., 12 woodcuts.

This is the first of two parts of a handbook of practical meteorology, and this part is historical. It is an excellent and convenient book and, we welcome it heartily. A large share of this part relates to the early errors of meteorology and the author's attitude in his treatment of them is apologetic,—not apologetic for them, but for taking up so much space with them. We think the apology is unnecessary. It is well to have a compend of superstitious and astrological meteorology, not to speak of other errors, and the perusal of the early history of a science is always instructive. In this case the treatment has fallen into good hands and a gap in the literature is worthily filled. One hundred and eighteen pages are devoted to lunar meteorology and sixty pages to sunspots· The influence of comets and meteors is also considered. The results are summed up with care, but for the present purpose, it is sufficient to give a translation of the general summation found on page 259. "All the preceding investigations have sufficiently shown that, in the present stand of our science, we cannot draw from imaginary or real cosmic influences any valuable practical foundations for weather-predictions, nor can we expect to do so in the future." The author thinks, however, that some of the problems involved deserve further study.

The remaining hundred and thirty three pages are devoted to matters of more recent and direct interest and to a list of the literature; especial attention is given to meteorological conferences and congresses and to the development of weather telegraphy in the principal States.

Under the latter head, the system of the Signal Service receives detailed and appreciative attention. In general, however, the author shows little familiarity with the American literature. Under the head of the moon Professor Chase's ideas certainly deserve attention, and Mr. Basnett has made a much greater stir in the matter. and is no more in error, than many of the writers cited by the author. Wiggins receives some attention, but Judge Butler is not so much as mentioned.

H.